Our Programs

At JSC, our chief responsibility is human spaceflight. This includes the planning and operation of the International Space Station and space shuttle flights. NASA's space shuttles have launched more than 2 million pounds of cargo and more than 500 crewmembers into space. And in the International Space Station era, we have already completed more than 16 flights – which include 12 space shuttle missions.

The International Space Station Program

The International Space Station is a bright star orbiting around Earth every 90 minutes, making its rounds over 95% of the Earth's population. Human spaceflight has been transformed through the International Space Station, and has evolved into cooperative endeavors of world nations, businesses and academic institutions. There is great hope ahead, and many countries are planning to reap many benefits from operating and using this incredible new station in Earth's orbit.

The International Space Station represents a global partnership of 16 nations, including the five partner countries: the United States, Russia, the European Union, Canada and Japan. It is an engineering, scientific and technological marvel ushering in a new era of human space exploration. The International Space Station has grown from a 70-ton, efficiency apartment-sized foothold in orbit to a space laboratory of unprecedented capability. The station is now a 150-ton orbiting complex with volume about that of a three-bedroom house.

As assembled, the International Space Station provides an environment where gravity, a fundamental force on Earth, can be controlled for extended periods. This ability to operate in microgravity opens up unimaginable research possibilities. Establishing a unique, state-of-the-art orbiting laboratory complex, the International Space Station will expand the parameters for space research. The unique capabilities of its laboratories will enable discoveries that may benefit people all over the world.

The Cellular Biotechnology Program at JSC uses NASA cell culture technology and the microgravity of space to advance ground-breaking research in biomedical science. Currently, NASA's biotechnology cell science research aboard the International Space Station is working to provide controlled cultivation of cells into healthy, three-dimensional tissues that retain the form and function of natural, living tissue. Studying normal growth and replication of human cell tissue outside

A Quick Look at the International Space Station

Total residents and visitors since start of assembly: 79

Men:	68	Women:	11

Crewmember nationality since start of assembly:

U.S.:	58	Italy:	1
Russia:	15	France:	1
Canada:	3	Japan:	1

Spacewalks since start of assembly: 38

Shuttle-based: 25 Station-based: 13

Station Expedition crew mission duration from time of official handover:

Expedition One:	136 days on station, 141 days in space
Expedition Two:	163 days on station, 167 days in space
Expedition Three:	125 days on station, 129 days in space

living organisms is difficult. However, cells grown in microgravity – the low-gravity environment inside spacecraft orbiting the Earth – much more closely resemble those found in our bodies here on Earth. Bioreactor-based cell growth in microgravity permits cultivation of in vitro tissue (outside an organism) cultures of sizes and quality not possible on Earth. Such a capability provides unique opportunities for breakthrough research in the study of human diseases, including various types of cancer and heart disease.

The Cellular Biotechnology Office is currently engineering station-based hardware components that will provide a controlled environment for cultivating cells in vivo (inside an organism). These components will act as an interim platform for cellular research until the permanent Biotechnology Facility is delivered.

The space station Biotechnology Facility will be a complete research laboratory facility with static- and rotating-wall bioreactors, analytical equipment for on-orbit analysis, systems for supplying gas mixtures to bioreactors and for low-temperature stowage, and computer systems and software to control and monitor facility and experiment hardware and to transmit experiment data back to Earth.

Protein Crystal Growth With science being performed on the station, scientists are no longer restricted to relatively short-duration flights to conduct structural biology experiments. In 2001, the Protein Crystal Growth-Single Thermal Enclosure System (PCG-STES) experiment flew within the U.S. Lab EXPRESS (Expedite the Processing of Experiments to the Space Station) Rack 4 during the Expedition Four mission. The PCG-STES experiments should accomplish three goals:

- First, establish a protein crystal growth facility that would greatly increase experiment and coinvestigator capacity, increasing the odds of obtaining suitable crystals and, consequently, increasing the overall science return from each mission.

International Space Station Quest Airlock: A Doorway to Space

In July 2001, NASA successfully delivered and checked out a new airlock, the "Joint Airlock" for the International Space Station. This was a critical flight for the space agency as it completed Phase II of the International Space Station, making the orbital outpost a crewed, self-sustaining platform for science and low Earth orbit observations.

The International Space Station Joint Airlock is currently operational for Extravehicular Mobility Unit (EMU) spacewalking use, and, when fully outfitted, it will support either U.S. EMU or Russian Orlan suit use for EVAs from a common portal on the International Space Station.

The installation of the Joint Airlock opened the door to station-based EVA capabilities for the U.S. Now, U.S. EVAs can occur without the shuttle docked for both maintenance tasks and to finish the International Space Station assembly work. Additionally, the Joint Airlock allows NASA to keep EVA hardware on orbit and thus fly less EVA equipment on the shuttle. The Joint Airlock also increases equipment transfer time by allowing hatches to remain open longer between the shuttle and the station.

The Joint Airlock gives the Space Shuttle and the International Space Station Programs many new EVA options for the International Space Station assembly, maintenance and docked shuttle mission use. The delivery of the Joint Airlock was a milestone in the International Space Station Program to facilitate future EVA endeavors.

International Space Station Milestones

- In July 2000, Service Module launch set in motion an unprecedented succession of spaceflights.
- A total of 24 flights gave us the 300,000 pounds of microgravity facility we have today, with nearly 15,000 cubic feet of living and working space and our fourth Expedition crew in residence.
- The addition of 19kW of power with the P6 solar array on STS-97, quintupled onboard computing and activated a fully functioning laboratory delivered on STS-98 in February 2001.
- In April 2001, a state-of-the-art robotics system was added by deploying the Canadarm2 station robotic arm.
- More than 50,000 hours of U.S. payload run-time have been logged since STS-106 in September 2000.

- Second, produce protein crystals of improved size and order in support of numerous structural biology and structure-based drug design research programs.
- Finally, use the facility to delineate factors contributing to the effect of microgravity on the growth and quality of protein crystals.

Astronaut Janice Voss, mission specialist, looks over a checklist on *Endeavour*'s aft flight deck. Just above Voss' shoulder is an electronic still camera aimed at Earth targets for the EarthKAM project.

EarthKAM The Earth Knowledge Acquired by Middle School Students (EarthKAM) is a NASA education program that enables thousands of students to photograph and examine Earth from a space crew's perspective. EarthKAM brings education out of textbooks and into real life. By integrating Earth images with inquiry-based learning, EarthKAM offers students and educators the opportunity to participate in a space mission and to develop teamwork, communication and problem-solving skills.

This program benefits the public as well as the students. First, it introduces Earth science research to thousands of middle-school students around the globe. Using the Internet, students control a special digital camera mounted in the window of the International Space Station U.S. laboratory. Then the EarthKam team collects these photographs and posts them on the Internet for public viewing. Long after the photographs are taken, students and educators continue to reap the benefits of EarthKAM. Educators later use the images alongside suggested curriculum plans for studies in physics, computers, geography, math, Earth science, biology, art, history, cultural studies and more.

Teaching from Space Program Our Teaching from Space Program's (TFSPs) goal is to facilitate educational opportunities that use the unique environment of human spaceflight. These opportunities are accomplished through partnerships with formal and informal educational communities aligned with national education standards and state curriculum frameworks.

TFSP develops comprehensive packages consisting of on-orbit opportunities, interactive Web sites, distance learning education programs and hands-on activities that support science, mathematics,

technology, engineering and geography curricula. In FY 2001, TFSP flew the first International Space Station education payload with the Expedition One crew and launched a second education payload with the Expedition Four crew. In addition, TFSP coordinated 13 live education programs for the International Space Station with potential impact to more than one million students around the world.

International Space Station 2002 and Beyond In 2002, Phase III assembly and operations of the International Space Station will continue to focus on expanding and powering up the station. Fulfilling the commitments NASA has made to the International Space Station partner countries will require support and leadership beyond program boundaries. As we move into the future, we will be challenged to keep the financial aspects of the program in balance with our technical performance. And budgeting is always at the forefront. In the future, we may need to consider a broader set of issues to meet the challenges brought on by a leaner budget. This will mean research prioritization and careful expenditure of resources.

The Space Shuttle Program

Our space shuttle remains the most sophisticated human spacecraft in the world. The shuttles are the driving force that enables us to build and maintain the International Space Station. The unprecedented and unequaled accomplishments of NASA's Space Shuttle Program were recently celebrated with the program's 20th anniversary. The shuttle, which was on the drawing boards even before humans first landed on the Moon in 1969, was envisioned as a way to deliver humans and cargo to and from a space station.

Mr. Estess' tenure as acting center director resulted in a stellar 14 months for the shuttle program. We flew seven flawless missions, starting with STS-98 in February 2001, and finishing with STS-109 in March 2002. All flights but one were dedicated to space station assembly and maintenance. The other mission was the servicing of the Hubble Space Telescope. We flew five flights in six months, a great tribute both to the expertise and diligence of the entire shuttle team, and to NASA as an agency dedicated to safety first and continuing the exploration of space.

Houston, Go for Launch

Since 1965, JSC's Mission Control has been the nerve center for America's human spaceflights. Since the International Space Station assembly began in 1998, the Center has become the focal point for human spaceflight worldwide. The teams that work in Mission Control, Houston, as it is most widely known, have been vital to every U.S. human spaceflight since the Gemini IV mission in 1965, including the Apollo missions that took humans to the Moon and the more than 100 space shuttle flights since 1981.

Now with a permanent human presence aboard the International Space Station, flight control teams of experienced engineers and technicians are on duty 24-hours a day, 365-days a year, monitoring spacecraft systems and activities. Flight controllers keep an unblinking watch on the crew's activities, monitoring the spacecraft's performance, checking and rechecking every number to ensure operations proceed as planned. These highly trained flight controllers have the skills needed to closely monitor and maintain increasingly more complex missions and then respond to the inevitable unexpected event.

Mission Control Center also coordinates with the Russian Control Center to support the International Space Station. This is a partnership that completed a successful year in 2001.

Who are the people behind the scenes? They are the astronaut trainers, mission planners, engineers and astronauts – Mission Operations. They design, direct, manage and implement overall mission operations for the Space Shuttle and the International Space Station Programs as well as plan future expansion and activities on the International Space Station.

Maintaining the long-term safety and viability of the Space Shuttle Program is a challenge that the management team has been examining. Since 1993, the program's workforce has been reduced by nearly 50%, and with that reduction came budget decreases as well. Yet we have not reduced the number of our flights. In fact, in FY 2001, we successfully flew that record number of seven demanding shuttle missions, all while staying within our budget.

The success of the Space Shuttle Program is due to the complementary skills and experience of the NASA and contractor workforce. Individually, neither the contractor nor the NASA workforce has the necessary and required skills to successfully operate the program. However, collectively the requisite skills and experience exist to maintain the safety and viability of the program. We must protect the future of the Space Shuttle Program by nurturing a new generation.

At JSC, we set high standards for successful and safe programs with a measurable return on investment. Safety and risk management continue to be major considerations in all of our programs, but especially in the Space Shuttle Program.

We have taken the leadership role in the development of a more useful assessment tool to aid in program decision-making. This effort is well under way, with complete systems assessment tools scheduled for release in March 2003. Initial phases of this software have already been used to evaluate upgrade candidates, and are proving to be a valuable tool.

The Industrial Engineering for Safety (IES) initiative is making dramatic improvements in risk reduction. This initiative, designed to evaluate and implement modifications to reduce workforce and collateral damage risk, currently has 25 funded projects and several more projects in study.

We have recently installed a "glass cockpit," or the Multifunction Electronic Display Subsystem (MEDS), on Space Shuttle *Atlantis.* The MEDS has increased capabilities, decreased weight and power consumption, and replaced obsolete equipment on the flight deck of the shuttle.

The 11 new full-color, flat-panel display screens in the shuttle cockpit replace 32 gauges and electro-mechanical displays and four cathode-ray tube displays. The cockpit display is 34 kilograms (75 pounds) lighter and uses less power than before, and its color displays provide easier pilot recognition of key functions. Similar technology, commonly called "glass cockpit" instrumentation, is already in use in commercial aircraft. The MEDS will be among the first U.S.-manufactured liquid crystal flat panel displays to be used in aerospace.

The new cockpit will be installed in all shuttles by the end of 2002. It sets the stage for the next cockpit improvement planned to fly by 2005: a "smart cockpit" that reduces the pilots' workload during critical periods.

Our flight schedule for 2002 will be just as demanding and exciting as this past year, with seven launches scheduled. The success of the last months has demonstrated the tremendous capability of the space shuttle and the team that "makes it happen." We have an aggressive schedule planned, including the recent successful completion of our first mission of 2002, a re-service mission to the Hubble Space Telescope with five EVAs.